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COVID-19 PANDEMIC'S ECOLOGICAL REPERCUSSIONS IN INDIA

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Abstract: The continuous COVID-19 pandemic has rendered daily life in every country around the world impossible. On March 24, 2020 the Indian government imposed a nationwide lockdown to stop the spread of the disease, which led to a full cessation of all human activity in India. The media soon began to report on unexpected drops in pollution levels and sightings of exotic animals. The writers of this review article examine the pandemic's direct and indirect environmental effects. Air pollution levels significantly decreased when industrial businesses and automotive traffic were stopped. The amount of water pollution was also seen to be declining. For several decades, unusual glimpses of the Himalayas from towns hundreds of kilometres distant went unnoticed, illustrating the impact of the decline in particle matter that reduces long-range visibility. An infrastructure that was not designed to handle large quantities of infectious wastes was threatened by a significant biomedical hazard as a result of the rising number of COVID cases and biomedical waste production. This review outlines the initial environmental impact that this fatal epidemic has had on mankind, though it is still too early to determine the full extent of the environmental impact of this pandemic.

Keywords: COVID-19, Lockdown, Environmental impact, Pandemic.

INTRODUCTION:

The 2019 novel Corona Virus (2019-nCoV), also known as SARSCoV-2, has spread quickly from its origin in Wuhan City in Hubei Province of China across the entire world in a matter of weeks, posing a threat of a public health disaster in the form of a pandemic (Singhal, 2020).

On December 31st, 2019, the Chinese government informed the World Health Organization (WHO) of the number of sellers at the Huanan seafood market who had pneumonia-like episodes with an unclear aetiology (Srivastava and Reddy, 2020).

More than 5.4 million instances and an astonishing 3,44,000 fatalities has been documented as of May 24th, 2020. The COVID-19 was divided into four stages by the WHO based on the spread of the disease. The COVID-19 was divided into four stages by the WHO based on the spread of the disease. Stage 1 (imported cases), Stage 2 (local transmission), Stage 3 (community transmission), and Stage 4 are among these stages (transmission out of control). In America, Spain, Italy, China, and other countries, the virus spread rapidly, resulting in Stage 3 Community Transmissions (Kumari and Shukla, 2020).

Due to an increase in incidents, the Indian government declared a nationwide lockdown beginning at midnight on March 24, 2020, in an effort to deter future crimes by enforcing social segregation (Pulla, 2020).

Extensive restrictions on travel were put into place for the first time perhaps since World War II, with all restaurants, theatres, and bars being shut down globally. International visitors who are stranded in the middle of their vacations as a result of worldwide aircraft cancellations or returns are destroying the aviation industry. With a $2.94 trillion GDP and a ranking of 5 among the most polluted nations according to the IMF, India is currently on lockdown and faces both a public health crisis and a financial shock. Due to the closing of all non-essential government and governmental offices with a rigorous "Work-From-Home Policy," nearly all non-essential industrial activity and human traffic in and

around large cities were abruptly and drastically stopped (Roy et al., 2020).

Movement restrictions, factory closures, and curfew hours caused the environment to appear to change from the usual state of anthropogenic contamination. Worldwide reports of an increase in animal sightings because of a lack of human activity have been made. There have been reports about the pollution levels decreasing after the lockout. On the other side, a massive rise in medical waste has become an environmental issue, raising concerns about re-infection and complicating efforts to dispose of it (Yu et al., 2020). The authors of this article talk about how COVID-19 has affected the environment in many ways.

AIR POLLUTION

Reduced Carbon Emission

There has been a significant reduction in carbon emissions, with China reporting a 25% drop as a result of factory closures and restrictions on vehicle travel. The CO emissions in Kolkata, an urban area in Eastern India with a population of 14.9 million and a CO_2 emission average of 417.31 ppm 2 (according to data from the 30 April 2020) (https://www.co$_2$.earth/), significantly decreased after the lockdown, with an average reduction of more than 40% in emissions as sampled from three different locations (Dhar et al., 2020). Another independent analysis reveals that the percentage of CO emissions that have decreased in Kolkata ranges from 24.56% (at Deshbandhu Park) to 45.37%. (at Sealdah Station). The variety in this range can be traced to the vegetation density in the various test areas (Mitra et al., 2020a).

In April 2020, India, the world's second-largest coal consumer, saw a sharp annual fall in electricity production. Industrial coal consumption decreased along with a roughly 19% reduction in average daily power generation, with the purchase index falling from 51.8 in March to 27.4 in April.

Air Quality Index

The NAMP (National Air Monitoring Program), which is run by the Central Pollution Control Board (CPCB) and State level pollution monitoring centres, records the AQI of 24 cities across India based on eight characteristics (PM10, PM2.5, NO, SO, CO, O, NH, and Pb).

Significant environmental risks result from high quantities of these contaminants. Smog, acid rain, and nutrient pollution in coastal areas can all be brought on by nox in particular. All Nox gases have NO_2 as an indication number two. Most NO_2 emissions are attributed to the fuel used in power plants and from automotive exhaust (Wang and Su, 2020).

New satellite photos from the Copernicus Sentinel-5P satellite of the European Space Agency (ESA) revealed that the tropospheric NO_2 columns over Mumbai and Delhi, India's two largest cities, has decreased by around 40–50% over the same time period in 2019. Data from the Moderate Resolution Imaging Spectroradio-meter (MODIS) on NASA's Terra satellite revealed an aerosol anomaly over India after the lockdown. The majority of the aerosol emissions in the Gangetic plains are caused by vehicles, power plants, and industrial coal use.

An analysis of the NAQI (National Air Quality Index) near the National Capital Territory of Delhi revealed a notable drop in pollutants during the shutdown that (study period till 14 April 2020). Even other pollutants like NO_2 (52.68%) and CO (30.35%) have exhibited a significant decrease in concentration, with an average concentration of PM10 and PM2.5 exhibiting negative shifts from 51.84% and 53.11%, respectively, during the lockdown (Mahato et al., 2020). In contrast to these tendencies, SO_2 (17.97%), NH_3 (12.33%), and O_3 (+0.78%) showed decreased reduction, showed a slight but constructive growth. The reduction in NO levels, which serve as scavengers for O_3 [$NO + O_3 = NO_2 + O_2$], can be linked to this. (Mahato and others, 2020).

According to a CPCB notification, Delhi's benzene levels have decreased by 47%. The overall reduction in PM10 and PM2.5 levels in NCR towns during the shutdown was above 48%. Faridabad had a remarkable improvement with a 55% decrease in PM2.5 levels, and Gurugram saw a 54% decrease in PM10 levels. Significant reductions in NO_2 levels were seen in Noida (68%), Ghaziabad (60%) and Gurugram (40%). However, Faridabad (17%), where NO_2 emissions were found to be substantially greater, showed a smaller rise. This is likely because of the gas-based power plants in and around Faridabad (CPCB).

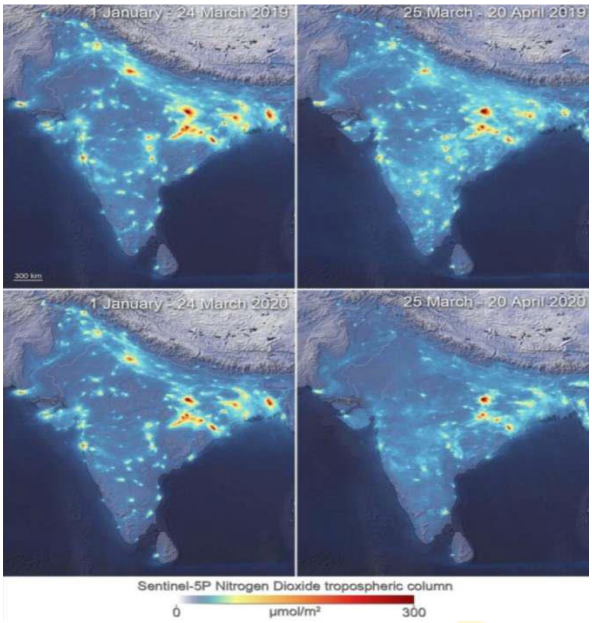

Figure 1: Nitrogen Dioxide concentrations (Source: ESA)

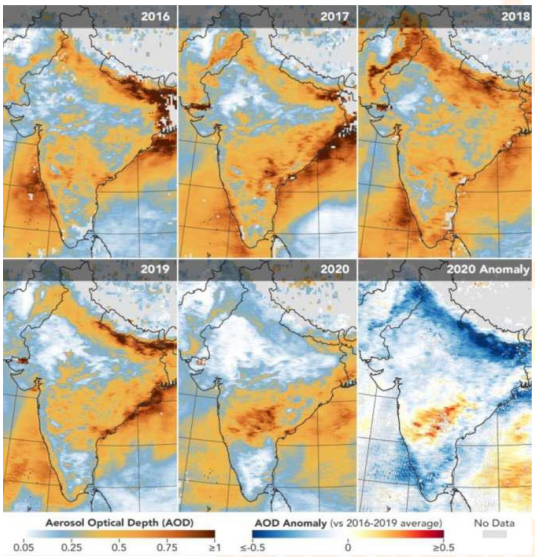

Figure 2: Aerosol Optical Depth and anomaly as seen in lockdown. (Source: NASA)

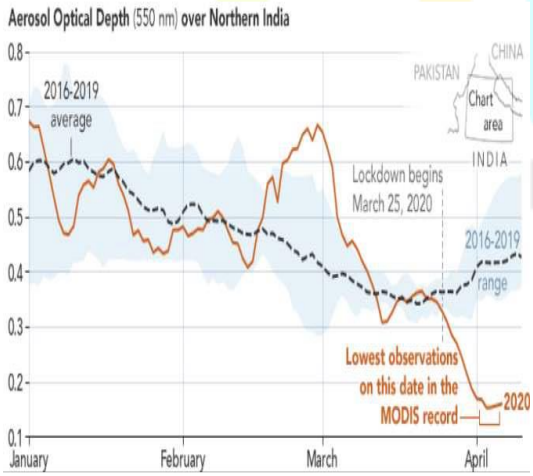

Figure 3: Aerosol Optical Depth Chart. (Source: NASA)

One of India's most polluted major cities is Bengaluru, referred as the Silicon Valley of India. A study of same Karnataka city, however, revealed a change in the AQI index during lockdown compared to levels in prior years, revealing "Satisfactory" values from "Moderate" levels.

During the lockdown, there was a noticeable drop in PM10 and NO_2 levels, with a 44% drop in PM10 and a 21% drop in PM2.5, a 53% drop in NO_2 and a 48% drop in Benzene levels (CPCB).

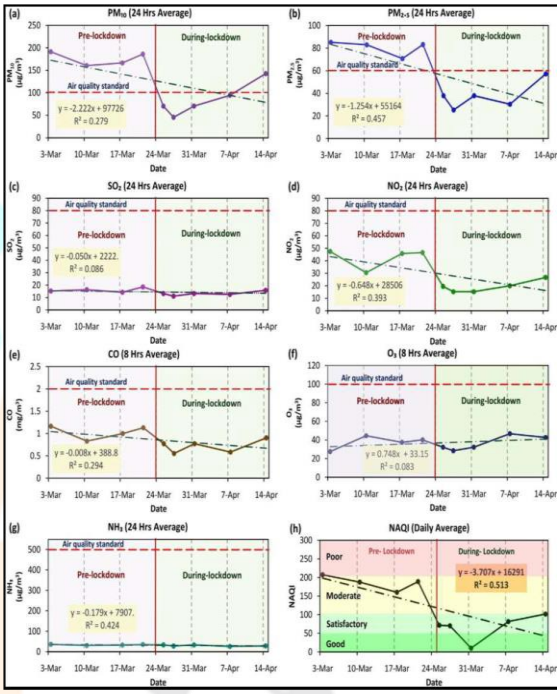

Figure 4: Trend of 24 h average concentrations of (a) PM10, (b) PM2.5, (c) SO_2 , (d) NO_2 , (g) NH_3 & (h) NAQI and 8 h average daily maxima of (e) CO & (f) O_3 between 3rd March and 14th April (lockdown started on 24th March) in NCT (Delhi, India) (Source: Mahato *et al*., 2020)

Date	Predominant Wind Speed (kmph)	Maximum Mixing Height (m)	Delhi	Ghaziabad	Noida	Faridabad	Gurugram
16-Mar	16	1800	139	134	118	184	165
17-Mar	12	1500	157	148	140	164	141
18-Mar	15	2000	151	172	137	164	168
19-Mar	14	3200	186	236	184	194	192
20-Mar	12	2400	192	235	195	212	175
21-Mar	16	2500	186	207	161	174	126
22-Mar (Janata Curfew)	12	2900	191	237	176	214	191
23-Mar	10	800	124	159	123	130	91
24-Mar	10	2700	122	166	130	187	127
IMPOSITION OF NATIONWIDE LOCKDOWN DUE TO COVID-19							
25-Mar	12	2500	77	86	80	100	69
26-Mar	25	1100	92	84	72	88	61
27-Mar	15	500	69	72	60	75	42
28-Mar	14	2250	45	39	38	64	54
29-Mar	20	2600	62	48	58	83	62
30-Mar	20	2100	71	64	61	97	76
31-Mar	12	1900	76	72	67	110	77
01-Apr	12	3200	73	79	73	90	69
02-Apr	20	3050	69	63	62	63	72
03-Apr	22	2100	79	104	72	97	82

Figure 5: Air Quality Index of NCR Delhi from 16th March, 2020 (pre-lockdown) to 3rd April, 2020 (Lock-down period). (Source: CPCB Bulletin)

The Super Cyclonic Storm "Amphan," which formed over the Bay of Bengal and is thought to be the most powerful storm to hit the Gangetic Delta since the 1999 Odisha Cyclone, made landfall in West Bengal on May 20, 2020, during the COVID Pandemic, causing extensive devastation. According to accounts, the storm's ferocity may have contributed to the lockdown's abrupt shift in weather. According to reports, the reduction of manmade aerosols may have contributed to the cyclone's intensification. Reduced levels of pollution and aerosol led to increased ocean surface heat, which served as a catalyst for the intensification of Cyclone Amphan.

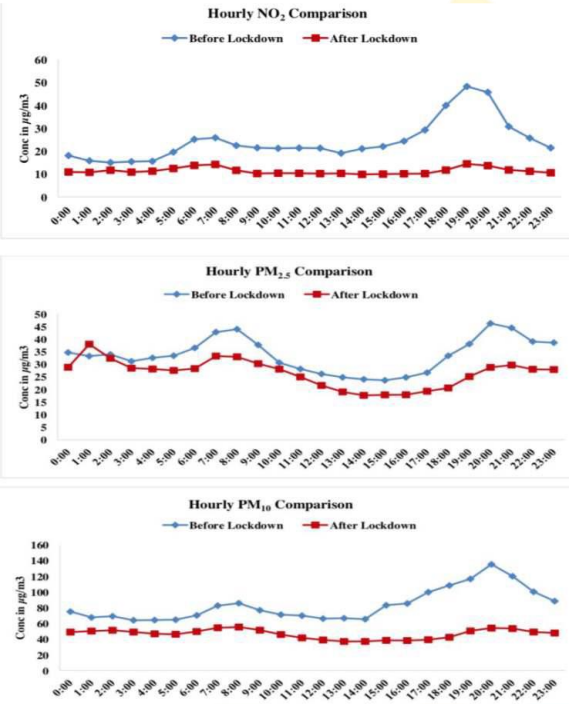

Figure 6: Air Quality Parameters comparison between Pre-Lockdown and After- Lockdown data in Bengaluru. (Source: CPCB Bulletin).

From Himalayas

The Dhauladhar mountain ranges of the Himalayas, with their snow-capped peaks visible from their roof tops, greeted the residents of Jalandhar in the Punjabi province as they awoke on April 3. A photo of the Gangotri Peaks of the Himalayas, which can be seen from the Uttar Pradesh town of Saharanpur, was posted on twitter by an IFS officer on April 29. It has been reported that this peaceful scene was seen after thirty years. The villagers of Saharanpur could see the Bandarpoonch mountain massif in the Garhwal region with their unaided eyes, its snow-covered peaks sparkling in the setting sun at 6313 metres above sea level.

Figure 7a: Himalayas visible from the city of Jalandhar (Source: CNN).

Figure 7b: Gangotri peaks visible from Saharanpur (Source:Financial Express).

WATER POLLUTION

Impact on River Ganga

The River Ganga, India's lifeline carries 3500 MLD via 97 towns throughout its length (million litres per day) of sewage, with industrial effluents making up around 9% of that total. The quality of the nation's water has improved overall throughout the lockdown due to higher dissolved oxygen (DO) levels and lower nitrate concentrations. The absence of industrial discharge, decreased agricultural runoff, and enhanced freshwater input are the main causes of this. Due to relatively less residential wastewater input, there was less biological oxygen demand (BOD) and chemical oxygen demand (COD) than usual. (Report by the CPCB). Due to the reduction in the deposition of domestic and industrial effluents, the water of the Rapti, Saryu, Ganga, and Yamuna rivers in urban areas also became clear and translucent (Verma and Prakash, 2020a).

Dissolved oxygen levels remained above the standards for bathing water (5 mg/l or more) throughout the lockdown period, but only slight improvements were noticed in most stations along Uttar Pradesh and significant improvements

were only noticed in a small number of monitoring stations (such as in West Bengal) after the second week of the lockdown. Only after 4 weeks did BOD begin to somewhat decrease. Nitrate concentration was on the decline (with the exception of West Bengal). (Refer to CPCB Report)

In and around Kolkata, a survey along six ghats revealed significant increases in DO post lock down. In April 2020, DO increased by 35.71%, 35.06%, 33.97%, and 35.06% in Princep Ghat, Botanical Ghat, and Babughat, and 2 Hooghly Bridge, respectively (Dhar et al., 2020).

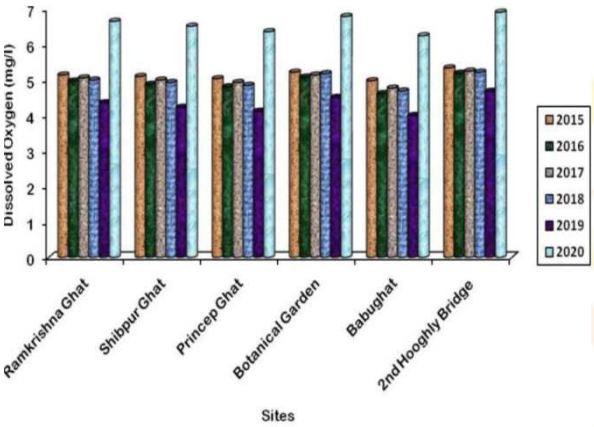

Figure 8: Spatial variation of DO level (in mg/l) in River Ganga (Dhar *et al.*, 2020).

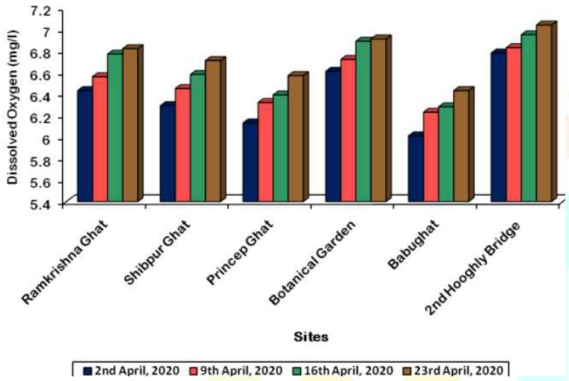

Figure 9: DO levels (in mg/l) in the study sites during lockdown phase (Dhar *et al.*, 2020).

Dissolved zinc levels in the Hooghly Estuarine System, a branch of the Ganga, revealed significant alterations after the lockdown, according to a research. The analysis revealed a dramatic decline in the otherwise growing trend of dissolved zinc in all three sampling stations, Kakdwip, Shankarpur, and Bony Camp, throughout the first to fourth week of April, 2020 (Agarwal et al., 2020).

Ganga has experienced a rise in acidity of its waters and an increase in its dissolved CO level in tandem with growing climatic change and waste water dumping (Dutta et al., 2020). An assessment conducted after the Second Lockdown at three locations along the Hooghly River's banks in Kolkata revealed that the acidity at all three locations had reversed. Data from 18 March (before to the closure) to 30 April (after the lockdown) indicated, respectively, 2.84%, 3.46%, and 4.99% at Ramakrishna Ghat, Botanical Garden, and Babughat. This may be because there are no longer any industrial discharges, fishing trawlers, or recreational activity on the ghats (Mitra et al., 2020b).

The CPCB crew conducted testing along the river at strategic locations in NCT Delhi as word spread on social media about an unexpectedly clean Yamuna front. The outcomes revealed a significant improvement in the Yamuna's water quality (with respect to DO, BOD and COD). This development is attributable to:

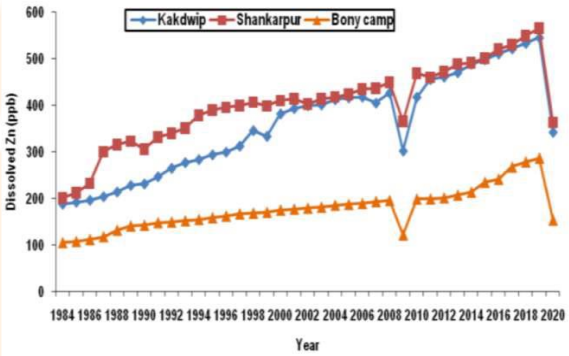

Figure 10: Variation of dissolved Zn during the study period (1984-2020). (Agarwal *et al.*, 2020)

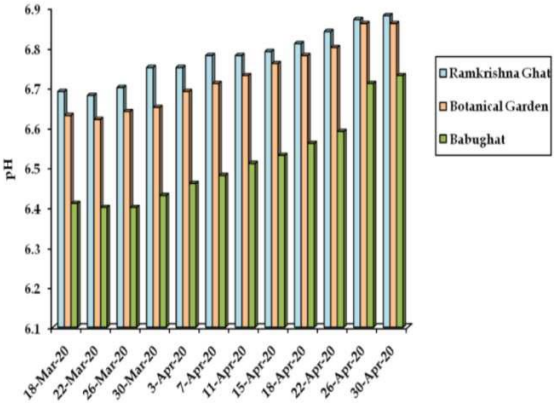

Figure 11: Spatiotemporal variation of pH during the study period. (Mitra *et al.*, 2020b)

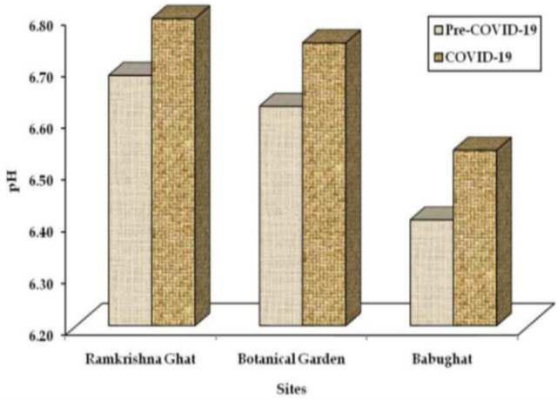

Figure 12: pH variation in the three selected sampling sites between pre-COVID-19 and COVID-19 lockdown period. (Mitra *et al.*, 2020b)

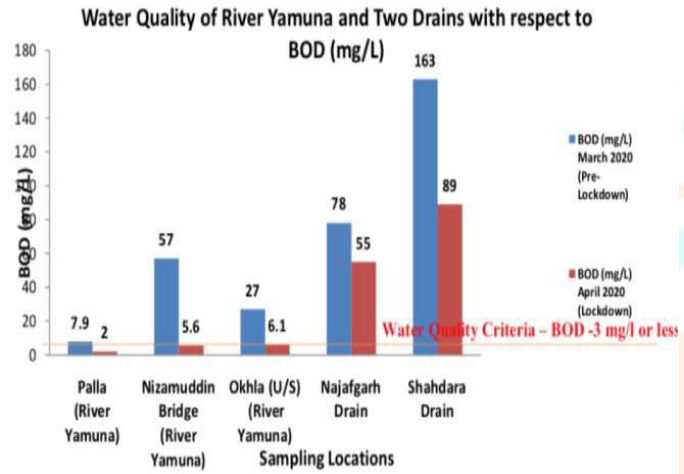

Figure 13: Water Quality Trend of River Yamuna and Two Drains with respect to COD (during Pre-Lockdown and Lockdown)
Source: CPCB Bulletin

a) Fresh water from the Wazirabad Barrage is released.
b) Industrial discharge was not present (35.9 MLD prior to lockout).
c) The water is cleared of the settling colloids in the riverbed by high solar penetration.
d) The absence of any habitation along the banks.

LIFE IMPACT ON BIOLOGICAL

An investigation into the ichthyoplankton community near the Haldia Port-Cum Industrial Complex revealed that environmental restoration had occurred because of the lockdown, which reduced oil-grease contamination in the estuary area (Pal et al., 2020). A comparable study in Diamond Harbour near the Hooghly estuary came to the conclusion that phytoplankton had a higher standing stock in April 2020.

Even the critically endangered Malabar Large Discovered Civet grabbed headlines after being spotted in the streets of Kozhikode, Kerala, with reports of rare sightings of Gangetic Dolphins around Babughat (Kolkata), to Meerut. The absence of people in these locations and the decline in pollution seem to be responsible for the increased visibility of these creatures.

Thanks to the area's clean air and low noise pollution, partial-migratory birds like the open-billed stork, spot-billed pelican, painted stork, grey heron, spoonbill, and ibis have been spotted staying longer in the Therthangal and Melaselvanoor-Keelaselvanoor bird sanctuary in the Ramanathapura Forest Range. A record-breaking 1,50,000 flamingos migrated through Mumbai, giving the wetlands a charming pink colour.

BIO-MEDICAL WASTES

Biomedical and electronic wastes are major issues for both humans and nature (Verma and Prakash, 2020b). A waste management nightmare is progressively developing as a result of the massive volume of biomedical waste that is being generated as a result of the growth in COVID-19 numbers.

Most of the biomedical waste produced during the pandemic is made up of PPEs, N95 masks, disposable bedsheets, and gloves. Approximately 14 kg more biological waste are produced daily by COVID patients than by typical patients. It has been claimed that rag-pickers in Pune have found used face masks. A guy in Thane was detained for drying 100,000 used face masks for resale.
There have been reports of unauthorised waste segregation of masks, discarded syringes, and personal protective equipment (PPE) at the Sharan Vihar camp for Rohingya refugees, close to Kalindi Kunj (Delhi). In preparation for separation and later sale as plastic waste, the neighbourhood was inundated with blue medical waste bags. Face masks and other medical waste might operate as a source of reinfection if they are not properly disposed of. On March 18, 2020, the CPCB released recommendations for the appropriate handling of medical waste. Some of the key instructions included color-coding trash cans, utilising double-layered bags, keeping an accurate waste inventory, and disinfecting with 1% sodium hypochlorite solution (CPCB).

DISCUSSION

The writers of this review documented how a pandemic pushed people to leave their homes around the globe while nature continued to thrive. Authors from India considered all environmental effects and noted a decline in animal sightings, air pollution, and water pollution. Medical wastes have increased throughout this pandemic, which has benefited nature but also increased the hazard of more plastic trash in the environment and the possibility of re-infection. Although the long-term effects of this lockdown on the environment as a result of the pandemic have not yet been determined, it is clear from the short-term data that nature has been significantly impacted by the lockdown as a precaution against the pandemic due to greatly reduced human movement and anthropogenic activities. Despite the fact that environmental improvement should not be celebrated when the entire world is ravaged by this terrible pandemic, people should be aware of the influence that manmade activities have—or don't have—on the environment at this time. This epidemic demonstrated to humanity the importance of sustainable development and its advantages for the environment. Nature appears to be healing as humanity struggles for breath.

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